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Sirenophila ovis-atra a new species of maritime Teloschistaceae from the Southern Hemisphere

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ABSTRACT. – A new species, *Sirenophila ovis-atra* is described from maritime rocks of southern Patagonia, the Falkland Islands and Macquarie Island, where it grows in the upper part of the black ‘*Verrucaria*-zone’, most often on members of the genus *Hydropunctaria*. It is so far the only known species of *Sirenophila* in South America, a genus that is particularly prominent on the coasts of Australia.

KEYWORDS. – *Caloplaca*, Chile, parasitic lichen, maritime zonation, Tierra del Fuego.

INTRODUCTION

The lichens of Southern Patagonia have in recent years been studied intensively particularly as part of the Spanish projects ANTCOMPLEX, POLARPIONER and PLANTSUCCESS. The Chilean part of Tierra del Fuego with Navarino Island and the canals and fjords north and south of the Cordillera Darwin were targeted during several sea based expeditions in 2005, 2008, 2009 and 2015. During these expeditions it was possible to study the maritime zones inhabited by lichens, particularly those belonging to the family Teloschistaceae. Rocky shores along cool oceans worldwide are known to display a characteristic zonation of lichen communities (Brodo & Sloan 2005, Fletcher 1980, Søchting et al. 2004) consisting of a lower black *Hydropunctaria* (formerly *Verrucaria*) zone, which upwards in elevation and closer to the land merges into an orange zone dominated by species belonging to Teloschistaceae. In spite of the overall visual similarity between the sea shores of distant continents the species composition differs significantly. Historically all those species with the yellow or orange anthraquinone pigments were placed in the genera *Caloplaca* and *Xanthoria*. However in recent years the delineation of these genera, together with others in the Teloschistaceae, has changed radically as a result of molecular study (see e.g., Arup et al. 2013). While many of the newly circumscribed genera lack discrete morphological synapomorphies, they do display strong phylogeographic patterns (Arup et al. 2013). Most striking is the very high diversity of the genus *Sirenophila* in Australia and New Zealand which contrasts to the presence of a similarly diverse genus *Austroplaca* in South America and Antarctica, meanwhile both genera are absent from coastal rocks of the Northern Hemisphere.

An apparently undescribed species belonging to Teloschistaceae was found growing quite abundantly along the Beagle Chanel in Tierra del Fuego at the very low edge of the orange zone, actually parasitizing the *Hydropunctaria* of the adjacent lower zone. Its affiliation to current Teloschistaceae genera was only possible after subsequent molecular studies that showed it to belong in the genus *Sirenophila*, a genus not previously known from South America. Further studies supported the novelty of the species, which is here described as *S. ovis-atra*.

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| Locality | Collection nr. | Herbarium | nrITS | nrLSU | mtSSU |
|---------------------|------------------------|-----------|-----------------|----------|----------|
| Chile, Navarino I. | <i>Søchting 12295</i> | C | KU578078 | | |
| Chile, Navarino I. | <i>Søgaard 90</i> | C | KC179306 | KC179250 | KC179589 |
| Chile, Navarino I. | <i>Søgaard 91</i> | C | KU578079 | | |
| Chile, Navarino I. | <i>Søgaard 106a</i> | C | KU578080 | | |
| Chile, Navarino I. | <i>Søchting 10176b</i> | C | KU578081 | | |
| Chile, Navarino I. | <i>Søchting 12341</i> | C | KU578082 | | |
| Chile, Punta Arenas | <i>Søchting 12386b</i> | C | KU578083 | | |
| Chile, Chaitén | <i>Frøden 1616</i> | LD | KU578084 | | |

Table 1. GenBank accession numbers and associated voucher information for sequences of *Sirenophila ovis-atra*. Newly generated sequences from this study in bold.

MATERIALS AND METHODS

The study is primarily based on material collected by the authors in Tierra del Fuego in southern South America (C, LD), supplemented with collections from Hobart, Australia (HO). In addition the following herbaria have unsuccessfully been screened for possible matches: British Antarctic Survey (BAS), Canberra (CANB), Farlow Herbarium (FH), Michigan State University (MSC). Macroscopic descriptions are based on observations made with a Wild Heerbrugg, M5-53204 dissecting microscope with measurements made using a mounted Nikon DS-Fi1 camera combined with the software NIS-Elements. Sections were made using a Reichert-Jung Cryostat 2800 Frigocut E microtome and viewed using an Olympus BX60 microscope. All measurements were made on material mounted in water. Ascospores were measured outside the asci, with size given as an average with standard deviation, and extremes written in brackets. The thickness of ascospore septa was measured at the outer wall in accordance with Vondrák *et al.* (2013). The number of measurements is indicated in brackets. Paraphysis morphology and measurements were made after soaking for 24 hours in an aquatic solution of Ariel Color™ detergent to dissolve lichenin.

The secondary metabolite pattern was identified using HPLC and analysed separately for thallus and apothecia. The relative composition of the secondary compounds was calculated based on absorbance at 270 nm according to Søchting (1997).

ITS sequences of the newly collected specimens were produced according to the procedures described by Arup *et al.* (2013), who had already published sequences of nrITS, nrLSU and mtSSU under the name “sp. 20”. All sequences were submitted to GenBank with the accession numbers indicated in Table 1.

THE NEW SPECIES

Sirenophila ovis-atra Søchting, Søgaard & Sancho sp. nov.
Mycobank #815606.

FIGURE 1.

DIAGNOSIS. – Thallus granular squamulose, grey, parasitic on *Hydropunctaria* sp. on maritime rocks; apothecia yellow with prominent margin; asci with 8 hyaline, ellipsoid, polardiblastic ascospores, ca. 14 x 7 µm with ca. 6 µm thick septum.

TYPE: **CHILE. XII REGIÓN DE MAGELLANES Y ANTARTICA CHILENA:** Canal Beagle, Seno Holanda, 54.9420°S, 69.1545°W, alt. 2 m, N-exposed overhanging rock, 1 m from the sea, 27.i.2015. *U. Søchting 12295* (C!, holotype; LD!, isotype).

ETYMOLOGY. – *Sirenophila ovis-atra* is named ‘the black sheep’ due to the deviating appearance, growth at the extreme limit of terrestrial habitats, and remote occurrence compared to its attractively orange relatives in Australia and New Zealand.

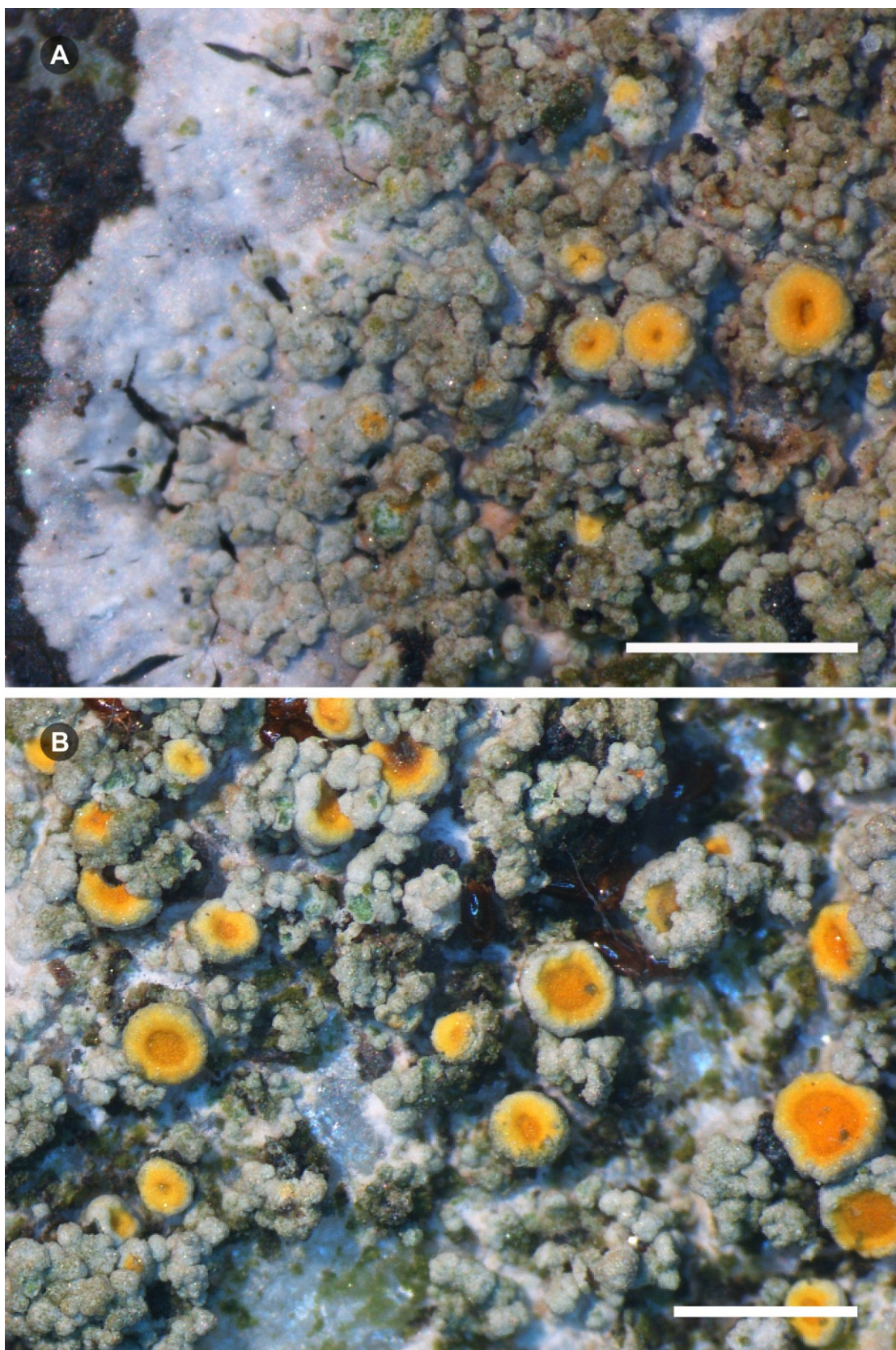


Figure 1, *Sirenophila ovis-atra* (both from the holotype). A, margin of young thallus on *Hydropunctaria* sp. B, central part of older thallus. Scale = 1.0 mm.

DESCRIPTION. – *Thallus* crustose, effuse, often with a grey appressed prothallus and with irregular, granular to slightly lobate, grey areoles often overgrowing *Hydropunctaria* sp. thalli; older thalli mostly fusing into a continuous, grey areolate crust with an occasional faint yellowish tinge (fig. 1).

Apothecia abundant, dispersed, zeorine, sessile, constricted at base, regular, up to 0.9 mm broad, initially strongly concave with prominent undifferentiated margin, later with a flat or slightly convex yellow-orange disc and a slightly prominent, 50–65 µm thick, concolorous proper exciple and a distinct, slightly crenulate, up to 60 µm thick thalline margin, concolorous with the thallus; *thalline margin* without or with an indistinct cortical tissue; *proper margin* hyaline, consisting of intricately interwoven hyphae that extend into the c. 50 µm high, hyaline *hypothecium*. *Hymenium* hyaline, 85–100 µm; *epihymenium* with medium coarse anthraquinone crystals on the surface; *paraphyses* 2–2.5 µm thick, branched, terminally only slightly swollen, up to 4 µm thick. *Asci* with 8 spores; *ascospores* ellipsoid, polardiblastic, (11.5)–13.8 ± 1.6–(17.3) × (6)–6.9 ± 0.5–8.5 µm [30], septum 5.8 ± 0.9 µm [30], ratio of septum/spore length c. 0.4

Pycnidia not observed.

CHEMISTRY. – The grey thallus is K-, C-, KC-, PD-, UV- and N- and contains no extractable secondary compounds. Orange pigmented parts of the thallus and the apothecia are K+ red. Parietin is the strongly dominant secondary compound in the apothecia corresponding to chemosyndrome A of Söchting (1997).

DISTRIBUTION AND ECOLOGY. – The new species is often parasitic on *Hydropunctaria* sp. on sheltered, maritime rocks at the transition between the black ‘*Hydropunctaria* zone’ and the orange ‘*Austroplaca* zone’, where it is often associated with *A. millegrana* (Müll. Arg.) Söchting, Frödén & Arup. It is probably common along the marine shores of Patagonia, but most likely largely overlooked due to its insignificant appearance, its concealed habitat and the lack of focused collecting in the region. It has been collected along the Chilean coast up to about 43° S, and is also recorded from the Falkland Islands and Macquarie Island (Australia). It may thus have a full circumantarctic distribution.

MOLECULAR RESULTS. – In addition to the sequences of nrITS, nrLSU and mrSSU that were published and deposited in Genbank by Arup et al. (2013) as “*Sirenophila* sp. 20”, seven new nrITS sequences of *S. ovis-atra* were produced for this study (see Table 1), five of which are 100% identical to “sp. 20” and two of which deviates from “sp. 20” in one and five positions out of 522, respectively.

In the phylogenetic analyses of Arup et al. (2013), *Sirenophila ovis-atra* (as “sp. 20”), was recovered in the genus *Sirenophila* in the subfamily *Teloschistoideae* of *Teloschistaceae*. Both in the three gene analysis and in the ITS analysis it was recovered as a sister species to *S. bermaguiana* (S.Y. Kondratyuk & Kärnefelt) Söchting, Arup & Frödén, which, like most other *Sirenophila* species, is known only from Australasia. The ITS sequence of *S. bermaguiana* available in GenBank (KC179299) deviates in 18 positions out of 522 from *S. ovis-atra*.

DISCUSSION. – Based on morphological or anatomical characters it is often impossible to discriminate many genera within *Teloschistaceae*, but molecular data already convincingly assigned the new species to *Sirenophila* in a prior study (Arup et al. 2013). This genus is very diverse in Australia and New Zealand, but has so far not been reported from the Northern Hemisphere, or from South America. *Sirenophila bermaguiana* from Australia is the closest relative based on the molecular results (see above) but the two species are morphologically very different. *Sirenophila bermaguiana* has an areolate, bright yellow to whitish thallus and very small, distinctly zeorine apothecia with orange discs (Kondratyuk et al. 2007 and Arup et al. 2013, fig. 52), whereas *S. ovis-atra* has larger, vivid yellow apothecia and a greyish thallus, and is restricted to sheltered maritime rocks mostly on *Hydropunctaria* sp. The ecology of the new species is analogous to two species of the mesic-supralittoral zone in the Northern Hemisphere, *Variospora thallincola* (Wedd.) Arup, Frödén & Söchting and *Flavoplaca microthallina* (Wedd.) Arup, Frödén & Söchting (Fletcher 1975). The almost total lack of orange pigmentation on the thallus is not an ecological modification due to low light intensities as *Austroplaca* species that grow with the new species display perfectly normal pigmentation. In Patagonia the maritime rocks above the *Hydropunctaria/ovis-atra* zone are occupied by a number of species belonging to *Austroplaca*, whereas similar habitats in the Australian region are abundantly occupied by the genus *Sirenophila*.

The ecology of *Sirenophila ovis-atra* is so extreme that it is unlikely to be found outside maritime habitats; however, it could occur under similar ecological conditions in other continents and thus be

described before. No species known from Australia comes close in morphology (Kondratyuk et al. 2012) and the one species with similar ecology and somewhat similar morphology from New Zealand, *Caloplaca papanui* D.J.Galloway has very thin septum, 1.5–2 µm (Galloway 2004). None of the publications of Carrol W. Dodge including his Antarctic Lichen Flora (Dodge 1973) include potential names for the new species, and our studies of lichen collections and literature pertinent to the Subantarctic Islands, Kerguelen, Crozet and Bouvetøya do not reveal relevant published species names.

Additional specimens examined. – **CHILE.** XII REGIÓN DE MAGALLANES Y DE LA ANTÁRTICA CHILENA: Province Antártica Chilena, Isla Navarino, 2 km E of Puerto Williams, maritime stone, in the upper part of the *Verrucaria* zone and the lower part of the *Caloplaca* zone, 0–2 m, 54.9297°S, 67.5725°W, 26.i.2008, on rock, *M.Z. Søgaard 90* (C), *M.Z. Søgaard 91* (C); E of Puerto Navarino, maritime cliff, 1–2 m, 54.9317°S, 68.3547°W, 28.i.2008, on rock, *M.Z. Søgaard 106a* (C); Caleta Honda, island in bay, 54.9153°S, 68.2259°W, maritime rock in *Verrucaria* zone, 1.ii.2015, on rock, *U. Søchting 12341* (C); 50 km SSW of Pta. Arenas, Fuerte Bulnes, 53.6321°S, 70.9130°W, alt. 3 m, on shaded, maritime rock, 8.ii.2015, *U. Søchting 12386b* (C). **X REGIÓN LOS LAGOS:** Chaitén, just outside central Chaitén, 42.9215°S 72.7190°W, 16.i.2001, on coastal rocks *P. Frödén 1616* (LD), *U. Arup L01145* (LD). **FALKLAND ISLANDS.** East Falkland, near Stanley, Murrell River, 51.65497°S, 57.92624°W, on shore of sheltered sea inlet, 2.ii.2015, on stones, *A. Orange 22656* (NMV-C.2015.004.66). **AUSTRALIA.** Macquarie Island, W side of The Isthmus, 4 m, 54.50°S, 158.95°E, 1995, on rock stack with *Verrucaria*, *R. Seppelt 19436* (HO).

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